



From Grid to Charger: How Electrical Contractors Can Capitalize on the EV Mega-Trend

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TRADE SHOW EDUCATION

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Today's Topics

- What's driving EV adoption and why this trend is accelerating
- How EV charging will transform the electrical market
- Simple to complex electrical distribution
- Where to look for revenue opportunities
- Questions



What's driving EV adoption? Why is the trend accelerating?

Electric Vehicles and Charging

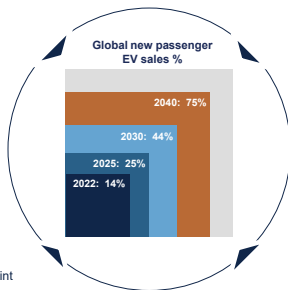
Why EV adoption? What's pushing the trend?

TECHNOLOGY

- Macro:**
- **Battery improvements**
 - Innovations in intelligence/control, autonomy and shared mobility
- Micro:**
- Early adopters, high performance, fun to drive

ENVIRONMENTAL

- Macro:**
- Global and regional **clean air and carbon** targets
- Micro:**
- Commitments by consumers and companies to **reduce carbon** footprint



ECONOMICS

- Macro:**
- Drop in **battery costs**
 - Investment markets, new job creation
 - Vehicle/fleet **utilization** models
 - Oil price volatility
 - Global **scale** driving down cost

- Micro:**
- Lower **energy and maintenance** costs
 - Easy access to electricity
 - EVs last longer

ENERGY SECURITY

- Macro:** **Energy independence and energy security** conserving oil & gas for critical needs (chemical/plastics, high density energy transportation)
- Micro:** Electricity = **local energy** production, local workforce

Note: Forecasted global penetration rates aggregated from recent analyst reports (BNEF, IEA)

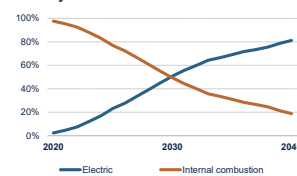


Transportation Electrification Opportunity

A growing & transformational market

EV sales will exceed ICE sales

U.S. share of new passenger vehicle sales by drivetrain



Electric Vehicle Outlook 2023. "US EV share of new passenger vehicle sales" BloombergNEF, Figure 80.

Vehicle segment sales projections

Type	New Sales	Year
Transit Buses	60%	2030
Passenger Cars	50%	2030
Light Duty Trucks	30%	2030
Medium Duty Trucks	20%	2030
Heavy Duty Trucks	20%	2030

Consolidated projections aggregated from recent reports from BNEF, IEA, IHS.

EV charging investment needed

Globally 40% CAGR from 2019-2026

Addressable Market in U.S.

- **28m** chargers needed by 2030
- **\$165 billion** in electrical hardware investment
- **\$25 billion** in forecasted services

Amounts may grow depending on acceleration of trend

- Building the 2030 National Charging Network. [NREL](#), June 2023

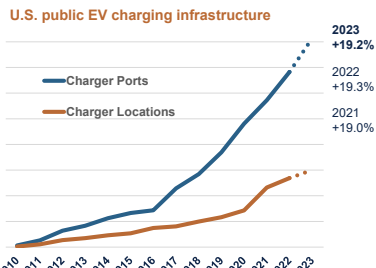
- Getting to 20M EV's by 2030. [The Brattle Group](#).

Market opportunity for EV charging will be significant and steadily grow



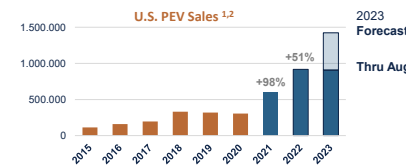
Indicators of U.S. Segment Growth

Infrastructure growth and PEV sales



Source: U.S. DOE, Sept. 2023. <https://afdc.energy.gov/data/>

LDV	PEV
Light duty vehicles (cars, SUVs, trucks, vans)	Plug-in Electric Vehicles (BEVs + PHEVs)



PEV share of new LDV sold in U.S. ²	2020	2021	2022	2023
	2.1%	4.1%	6.7%	8.9%

1 - Argonne National Lab, Aug 2022. <https://publications.anl.gov/anlpubs/2021/06/167626.pdf>
 2 - Argonne National Lab, Aug 2022. <https://www.anl.gov/es/light-duty-electric-drive-vehicles-monthly-sales-updates>



Three "Trillions"

Not a typo

Automaker investment

30+ global automakers will invest

\$1.2 trillion



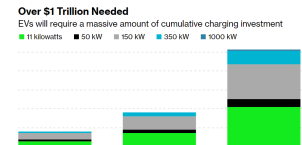
Source: Reuters, Oct. 2022

Global infrastructure by 2040

Global EV infrastructure investment:

\$1 trillion

~25% will be in the U.S.



Source: Bloomberg, Aug. 2022

Global EV spend through 2022

Passenger EVs
\$1+ trillion
 Commercial EVs
\$175+ billion
 Charging Infrastructure
\$62+ billion

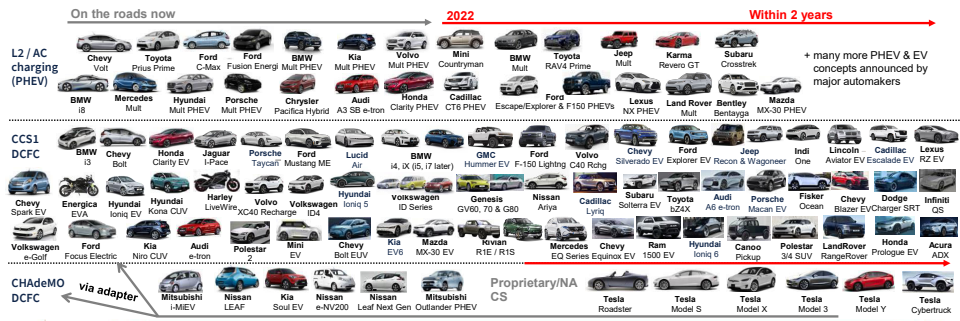
60% of all EV-related spending occurred in last 18 months

Source: Bloomberg, Feb. 2023



Electric Vehicles and Charging

Light-duty vehicles for North American market



Red text indicates OEM confirmed high-voltage battery pack design for enhanced charging speed at higher power DCFC sites
100+ plug-in models will be available in the United States by 2025



Electric Vehicles and Charging

Medium and heavy-duty electric vehicle OEMs making vehicles for North America



SOURCE: CALSTART (2022) Drive to Zero's Zero-emission Technology Inventory (ZETI) Tool Version 8.0.
 Available online at <https://globaldrivetozero.org/tools/zero-emission-technology-inventory/>



How will EVs transform the electrical market?

Megatrend – Transportation Electrification

Energy from liquid fuels will move through electrical infrastructure



Massive infrastructure change needed
 This megatrend will accelerate for 20+ years, drive \$1 trillion investment globally by 2040¹

¹ – BNEF 2022 EVO – full report – <https://about.bnef.com/electric-vehicle-outlook>







All-new electrical infrastructure → **All-new funding (Additive)** → **Increasing use of electrical products and services** → **Installed and invoiced by ECs**



EV Grid-to-Charger



\$165 billion U.S. addressable market by 2030



Utility Grid	Gear & Grid Edge	Charger	Vehicle
Grid upgrades to support EV adoption \$75 billion	Customer-side gear connects grid to charger \$40 billion	EV chargers 28 million ports \$50 billion	


The 2021-22 acceleration (IIJA, IRA, EV adoption rates) continues to increase addressable market

Sources – Edison Electric Institute and The Brattle Group
<https://www.eei.org/News/news/All/eei-projects-26-million-electric-vehicles-will-be-on-us-roads-in-2030>
https://www.brattle.com/wp-content/uploads/2021/05/19421_brattle_-_opportunities_for_the_electricity_industry_in_ev_transition_-_final.pdf






EV Grid-to-Charger

More than chargers




← **EV Charging planners start here and move left**






Electric Vehicles and Charging

From slow to fast charging







120 VAC		208-240 VAC		480 VAC	
AC Charging – Hours				DC Charging - Minutes	
AC “Level 1” Charging ~1 kW 8-16A	AC “Level 2” Charging 3-19 kW 16-80A	DC Fast Charging 24-50-180 kW 40-125-200 A	DC High power 175-350 / 450 kW 200-500 / 600 A		
Residential and workplace charging (Destination) When a car, truck or bus is parked all day or overnight		Public / highway / buses and trucks (On the Go) When a recharge is required very quickly / large battery vehicles			
Time to charge: 8-48 hours	4-20 hours	15-60 minutes	5-15 minutes		
Range per hour: 3-5 miles	15-80 miles	90-300 miles	300-600 miles		

Charger type/quantity determines electrical equipment

Starting point: Recommended upstream circuit breakers

240v		480v		
Level 2 AC	DC Wallbox	Fast DC	DC High Power	DC High Power – Bus
				
9.6 kW – 50A 19.2 kW – 100A	24 kW – 125A 240v 24 kW – 40A 480v	50 kW – 80A 90 kW – 150A 120 kW – 200A 180 kW – 300A	175 kW – 300A 350 kW – 600A	150 kW – 250A 300 kW – 500A 450 kW – 750A

Note: Upstream circuit breaker amperage not equal to charger output amperage

Simple to complex electrical opportunities

(for illustration only)



Level 2 AC Wallboxes – 9.6 kW

Overnight fleet, multi-family, parking decks, hotels



Alternative: Two lighting panels for lower cost and less space required for access / clearance



Power Panelboard



Surge Protective Device (in panel)

16x Level 2 AC wallbox chargers (9.6 kW)

50A for each

800A total



Charge time 4-10 hours

Fast DC – 180 kW

Convenience fueling stations, highway truck stops, travel plazas



Surge Protective Device (in panel)



Switchboard



Safety switches



Optional: LV step-down transformer for lower voltage devices onsite

8x Fast DC chargers (180 kW)

300A for each

2400A total



Charge time 15-30 minutes

DC High Power – 175 kW or 350 kW

Highway corridor travel, metro 'charge and go', medium/heavy-duty fleets

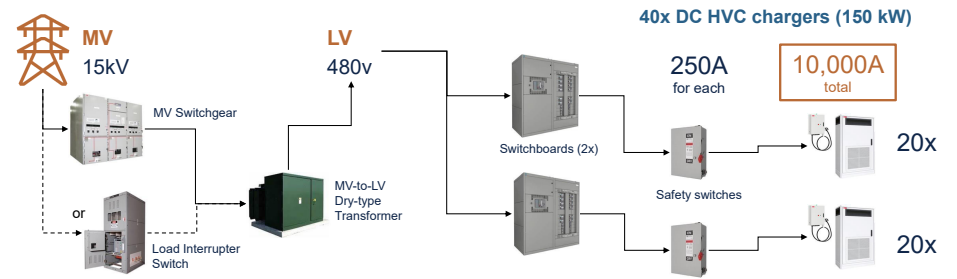


Charge time 5-30 minutes



DC Heavy Vehicle Charging – 150-600 kW

Bus depot and heavy vehicles

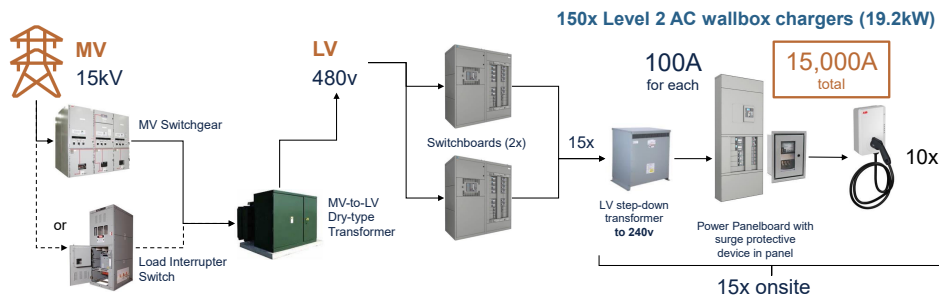


Charge time 3-5 hours



Mass Level 2 AC Wallboxes – Fleet trucks – 19 kW

Overnight mega-fleets



Charge time 4-8 hours



Two types of load/charge management

When utility connection is not sufficient for EV charging

Cloud energy management

- Many manufacturers offer a version of this, uses software inside charger
- Usually used at smaller sites
- Uses OCPP to send commands to reduce power output of chargers
- Set by parameters: schedule, vehicle type, demand peaks, virtual site limitation, etc.
- Requires connection to receive new commands - uptime impacts functionality

Hardware + cloud energy management

- More robust solution with site-based hardware controller
- Can support very large sites with dozens of chargers
- Can use OCPP and more secure, industrial protocols
- Can connect to electrical gear to read loads, adapt charging output
- Dynamic energy management based on site factors
- Lower latency, more reliable than cloud-based (great for fleets and high-redundancy applications)
- Some can control local BESS or microgrids at charging site

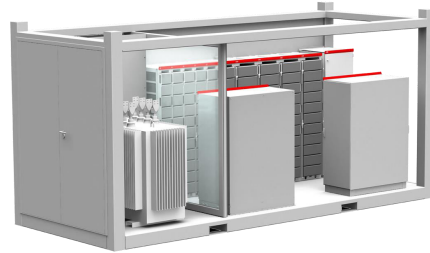


BESS and Microgrids

Charging-adjacent technology becoming more common

Benefits and applications at EV charging site

- Peaking capacity / peak shaving
- Time-of-use optimization / demand management
- Back-up power support
- Islanding mode
- Synchronized charging
- Renewables integration
- Power quality / frequency response
- Energy management
- Energy shifting



Code Considerations

National Electrical Code

NEC Article 625 – “Electrical Vehicle Power Transfer Equipment”

Size loads for continuous duty unless load management system is used (625.42)

- Installation must be marked to identify load management

EV chargers don't have inrush current like motors – they're similar to resistive loads

2023 updates:

- **Revised 625.42 Rating** detail for load management (distinct EMS or charger-based)
- **New Information Note 5** (based on NECA 413-2019) for installing and maintaining EV supply equipment (Levels 1, 2, and 3)



Many owners opt for separate utility service for EV charging loads

- Visibility for easy tracking and billing – separation of EV charging loads required for certain grant funding, tax credits, or LCFS credits
- Can be easier to add new service/equipment than upgrade existing equipment
- Can qualify for fleet rates (where applicable)
- New utility drop might be easier than running conduit from existing – depending on where chargers will be located
- Future bi-directional charging needs
- Can be easier to separate EV charging assets



Where to look for revenue opportunities









Opportunity by Type

Opportunity	Examples
 Large delivery fleets	Amazon, DHL, Fedex, Walmart, UPS
 Passenger car rental fleets	Avis-Budget, Enterprise-National-Alamo, Hertz-Dollar-Thrifty-Firefly, Sixt, Zipcar
 Commercial rental/leasing fleets	Kingbee, Merchants Fleet, Mike Albert, Penske, Pride Group, Ryder
 Autonomous taxi fleets	Waymo, Cruise
 Retail supply chain fleets and 3PLs	Target, Kohl's, XPO, JB Hunt, etc.

■ Large opportunity now □ Large opportunity 6-12 months



Opportunity by Type

Opportunity	Examples
 Charge point operators	Blink, ChargePoint, Electrify America, EVgo, Tesla, Volta
 Convenience fuel stations	Applegreen, BP, Chevron, Circle-K, Exxon, 7-Eleven, Shell, Wawa
 Truck stops, travel plazas	Love's, Pilot Flying J, TA Travel
 Restaurant parking and home food delivery	Taco Bell, Sonic Drive-in, Domino's Pizza
 Charging integrators	ABM, BP Pulse, Shell Recharge, InCharge, NovaCHARGE, The Mobility House, Voltera
 Mobile charging and battery swappers	SparkCharge, Ample

■ Large opportunity now □ Large opportunity 6-12 months










Opportunity by Type






Opportunity type	Examples
 Large hotel operators	Choice, Hilton, Intercontinental, Marriott, Starwood, Wyndham
 Large commercial property managers	Avison Young, CBRE, Colliers, Cushman & Wakefield, JLL, Newmark Knight Frank
 Auto Dealers	Light-to-heavy vehicle dealers
 Multi-family dwellings	Multi-unit developers, property managers
 Local offices	Real estate developers, property managers
 Retail/shopping centers	Real estate developers, property managers
 Large parking decks	Developers/cities/parking companies

■ Large opportunity now □ Large opportunity 6-12 months



Opportunity by Type

Opportunity type	Examples
 Transit bus fleets	City transit agencies
 School bus fleets	School districts
 Corporate employee transportation	Various companies
 Local light-duty fleets	Taxis, delivery, HVAC, plumbers, roofers, contractors
 Medium and heavy-duty truck fleets	Trucking services, WattEV
 Seaports (drayage trucks, yard tractors)	Local seaport authorities
 Airports (ground-side)	Local airport authorities

Opportunity type	Examples
 Federal Government (direct procurement)	GSA, VA, DOT, FBI, DoD, etc.
 Utilities – own fleets	
 Utilities – public roadside charging	<ul style="list-style-type: none"> • Large Investor-Owned Utilities • Municipalities • Co-ops
 Utilities – make ready	
 Utilities – grid upgrades	

■ Large opportunity now □ Large opportunity 6-12 months



Utility Opportunities

Utilities investing in four main areas

Utility fleets

Utilities will electrify their own truck fleets over time.



Roadside charging

Many utilities will build and operate roadside charging stations, opening new revenue streams. They may also join utility coalitions to create regional highway charging networks.



Make-ready programs

Utilities go beyond the meter to produce a nearly-complete "stub" site for a charger.

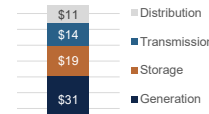
The utility locates, designs, builds, maintains, owns, and operates infrastructure connecting the customer meter to the charger without owning the charger itself.



Grid upgrades

Electricity demand will rise due to EV adoption and charging, requiring large investments from utility companies.

U.S. Utility Investments
(20 million EVs by 2030)¹



\$75 billion total



1 - Brattle Group, June 2020



Rebates help drive the market

Where to look

Utility rebates

Make-ready programs

Utilities go beyond the meter to produce a nearly-complete "stub" site for a charger

- Utilities fund the program completely or offer rebates to end-user where equipment is installed
- Wide scope: Single family homes to transit stations
- Not universal: Differ by state/utility
- More common with IOUs, but public power can also offer rebates

- Investigate with utility if they are running make-ready programs or offering make-ready rebates

State rebates

Look for funding from state departments:

- Dept. of Transportation
- Dept. of Energy
- Dept. of Commerce
- Dept. of Ecology
- City Depts. of Transportation

ZEV states – 12 states (so far) adopting the Zero Emission Vehicle program, offering incentives for vehicle manufacturers and/or buyers.

- There will be **more EV infrastructure activity** in ZEV states due to incentives

VW Settlement funding

As part of settlement, VW was required to create **Environmental Mitigation Trust** Funding for clean vehicles and charging infrastructure

\$2.8 billion was allocated across 50 states and Washington D.C.

- Look for funding in your state that will be awarded to cities/towns/public agencies for local projects

Most states still have Volkswagen funding available

www.environmentalmitigationtrust.com



Bipartisan Infrastructure law (IIJA)

funding for NEVI public charging

\$5 billion over 5 years

NEVI – National Electric Vehicle Infrastructure

- Federal "formula" funding for each state based on size/population/etc. Applies to chargers, related equipment.
- State DOTs submitted plans for funding, Federal DOT has approved all plans
- Various potential recipients for state funding – CPOs/fuel centers/new business models
- Minimum 4x 150kW chargers, 50 miles apart or less
- 97% uptime, within 1 mile of designated highways
- Funding began early 2023 – each state has its own program

Other federal grants for EV in Infrastructure law

- \$2.5 billion public charging
- \$5.5 billion Lo/No emission buses
- \$5.0 billion clean school buses



EV Charger Service

Opportunities for contractors

OEM-specific training

Many EV charger OEMs offer specific training and certifications for:

- Installation
- Commissioning
- Maintenance
- Repair

This is typically for:

- End-users of chargers
- Authorized service providers
- Charger integrators/resellers

Authorized service providers

Some EV charger OEMs offer dedicated programs for authorized service providers to service customer chargers

- Often on behalf of the OEM
- Full-service capabilities (install, commission, maintain, repair)
- Legal agreement signed
- OEM training required

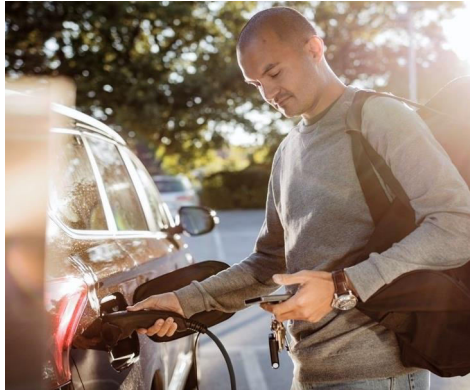




Future Trends

- V2X – bidirectional charging
- VPP and energy trading
- Charge management
- Microgrid and BESS
- Wireless charging
- Electrified roads
- EV ecosystem

Let's talk about it – booth 812



EV Charging = Huge Opportunities

All-new electrical load

Once-in-a-generation investment

Opportunities for ECs now and in the coming years

All-new funding, same communities, same wheelhouse



Questions?



Let's talk – come see us in booth 812



Complete the Online Evaluation

